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THE MANUAL FOR THE RADIOLOGICAL LABORATORY

Third Quarterly Report

15 September - 15 December 1951

SANITIZED VERSION

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This report covers the investigative work leading to and the preparation of a manuscript for a manual to be used in the radiological field laboratory, as required by the Joint Military Characteristics for the Mobile Radiological Field Laboratory.

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By Authority of ARMY DAMH-HSR-D#900334 13 Mar 90  
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Contract Da-36-039sc 5495  
Signal Corps Project No. 26-216A-1  
Department of the Army No. 3-12-06-061  
JTF-3 Project No. 201-2

Prepared by: René D. Zentner

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**Defense Threat Reduction Agency**

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*Ar dith Jarrett*  
ARDITH JARRETT  
Chief, Technical Resource Center

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THIRD QUARTERLY REPORT  
INVESTIGATION LEADING TO AND INCLUDING  
PREPARATION OF MANUAL FOR RADIOLOGICAL FIELD LABORATORY

TRACERLAB, INC.  
Western Division

ABSTRACT

After the fifteenth of September the preparation of the manual chapter drafts was well under way. New procedures for determinations of various isotopes or energies of activities were examined and tested for inclusion in the manual, and correspondence had been initiated with other organizations which might have additional information on various specialized subjects. The manual chapter on the biological effects of radiation was being prepared by Dr. C. A. Tobias of the Donner Laboratory of Medical Physics, University of California at Berkeley.

Certain chapters of the manual were thus ready for testing during the Signal Corps participation in Operations Buster and Jangle, the Fall weapons tests at the Las Vegas Test Site. These drafts were sent to Mr. Anderson, the Tracerlab radiochemist working with the Signal Corps party at the Site, and criticized in the light of the actual field operation.

### PURPOSE OF CONTRACT

The purpose of this contract is to effect the research required for the preparation of a manual to be used in the Mobile Radiological Field Laboratory. The research includes a survey of the relevant literature, both classified and unclassified; an examination of chemical and physical radioanalytical techniques now in use by the contractor and other laboratories; field experimental work at Operation Greenhouse; and such related experimentation or consultation as is necessary.

The completed manual will present:

1. Background information necessary for performing the mission of the field laboratory.
2. Procedure for determining the type, quantity, energy and decay rate of radiation from airborne particulate matter, liquids and solids in an area contaminated with radioactivities.
3. Procedures for decontaminating the field laboratory and its personnel.

and the presentation will be in a form readily understood by a reader having a background of two years college science.

I. THE PROGRESS OF THE MANUAL FOR THE MOBILE RADIOLOGICAL FIELD LABORATORY

A. Conference with Mr. Philip Shapiro, Evans Signal Laboratory, Belmar, New Jersey

As agreed earlier, the September conference between representatives of the Signal Corps and of Tracerlab, Inc., was held at the Western Division, Tracerlab, Inc., at Berkeley, California. Mr. Philip Shapiro, Acting Chief, Special Projects Section, Evans Signal Laboratory, Belmar, New Jersey, conferred with R. D. Zentner and E. E. Anderson and discussed the form and content of the manual. Samples of chapters already prepared were examined, and the format of the manual established.

Several questions were raised regarding new techniques to be investigated in the Fall weapons tests to be performed at the Las Vegas Test Site. These new techniques will be discussed in an appropriate section of this report.

B. The Preparation of the Manual by Members of the Tracerlab, Inc. Staff

It was stated in the previous Quarterly Report on this project\* that authors representing each of the fields covered by the manual chapters would be employed. These authors would be, wherever possible, drawn from the staff of the Western Division, Tracerlab, Inc. and would include members of the electronics and chemistry groups. The following table indicates the chapters and authors.

---

\*The Manual for the Radiological Field Laboratory  
Second Quarterly Report, 15 September 1951  
Tracerlab, Inc.  
Contract Da 36-C39-sc-5495

<u>Chapter</u>	<u>Author</u>
1. A brief account of the principles of radioactivity.	R. D. Zentner, Chemistry Department
2. A brief account of the principles and types of instruments in the field laboratory.	W. H. Faulkner, Electronics Department
3. A brief general account of the use and calibration of the field laboratory instruments.	J. H. Knapton, Electronics Department
4. The collection and preparation of airborne activity samples.	R. D. Zentner, Chemistry Department
5. The collection and preparation of solid activity samples.	R. D. Zentner, Chemistry Department E. E. Anderson, Chemistry Department
6. The collection and preparation of liquid activity samples.	R. D. Zentner, Chemistry Department E. E. Anderson, Chemistry Department
7. Chemistry procedures for separating and identifying radioactive isotopes, including fission products and irradiated soil components.	E. E. Anderson, Chemistry Department L. J. Beaufait, Chemistry Department A. DeHaan, Chemistry Department
8. Procedures for counting isotopic emission from all samples.	H. E. Menker, Chemistry Department
9. Principles and procedures of decontamination.	R. D. Zentner, Chemistry Department L. J. Beaufait, Chemistry Department L. Leventhal, Chemistry Department
10. Biological effects of radiation.	Dr. C. A. Tobias, Donner Laboratory of Medical Physics, University of California, Berkeley, California.

The preparation of the last chapter will be discussed in the next section of this report.

The chapters were prepared from outlines which had been set up by all contributing authors. Each chapter was drafted, the drafts reviewed by the Manual Contract Project Leader, and any recommended alternations discussed.



Concurrent with the preparation of the drafts the illustrations required for the chapters were sketched and the drawings or photographs corresponding to the illustrations procured. Mr. Anderson was assigned to be the Tracerlab chemist who would work with the Signal Corps field laboratory party at the Fall weapons tests.

By the middle of November drafts had been prepared of all chapters and most of the operating chapters had been sent to Mr. Anderson at Las Vegas. It was contemplated that these drafts would be reviewed by the group working in the field laboratory and any omissions or Nuclear portions could be corrected prior to the submission of the manuscript to the Signal Corps.

In a meeting at the Las Vegas Test Site on 15 November between Messrs. Shapiro, and Blair of the Signal Corps, and Messrs. Zentner and Anderson of Tracerlab Inc., it was agreed that the submission of the Manual manuscripts would be postponed until the information gained at the Las Vegas tests could be incorporated in the manuscript. Since the Mobile Radiological Field Laboratory, Radiac Set AN/MDQ-1 (XE-3) used at the Fall tests was scheduled to leave the site on 6 December, it was expected that the manuscript would be available some time after this date.

C. The Preparation of Chapter 10 by Dr. C. A. Tobias

The tenth chapter of the manual will be devoted to a review of the biological effects of radiation and a discussion of the hazards of the emission from bomb debris and radiological warfare agents to field laboratory personnel. Since the Tracerlab staff did not include qualified medical personnel, it was decided to approach the medical research group at the University of California for assistance.

At the recommendation of Dr. John H. Lawrence, Director of the Donner Laboratory of Medical Physics of the University, the Tracerlab group retained Dr. C. A. Tobias of that laboratory as a consultant. Although it was first expected that Dr. Tobias would do no more than edit a draft prepared by the Tracerlab group, it was subsequently found that Dr. Tobias' contribution included the rewriting of the draft submitted to him and the inclusion of a great deal of data unavailable to non-medical authors.

Dr. Tobias began his consulting to the Western Division on October 1, 1951 and turned in his completed draft on November 28, 1951.

One question remained unanswered in the preparation of this data. Although some levels have been set on the ingestion tolerances for isotopic radiation, no information was discovered on the solubility and fate of particulate bomb debris in the body. Owing to the absence of such data, it was not possible to discuss the hazards of bomb debris ingestion in terms other than that of gross activity. Since the literature studied deals with the metabolism of separated isotopes, it was not possible to determine whether a given fission product isotope could be leached from the solid debris and undergo a specific metabolism or whether it would follow the solids.

In the course of studying this phenomenon, Mr. Zentner contacted Dr. A. L. Baietti, Head of the Radiological Safety Branch of the U. S. Naval Radiological Defense Laboratory, San Francisco, California to discover whether Dr. Baietti's group had any recent information on bomb debris metabolism. Dr. Baietti reported that although the U.S.N.R.D.L. was actively studying the problem, no information was available at this time. A copy of his letter appears as Appendix 1 of this report.

#### D. Consideration of Manual Techniques

In the course of preparing the manual, a number of questions and comments regarding techniques have arisen which it is convenient to present here.

##### 1. The Determination of Alpha Activity

Consideration has been given to the question of determining specific alpha-emitting isotopes in bomb debris. The field laboratory is provided with an alpha-sensitive scintillation probe for determining the presence of alpha radiation in samples; but the determination of specific  $\alpha$ -emitting isotopes presents several difficulties.

At this writing, the chemical determinations of the main  $\alpha$  emitters of interest  ${}_{92}\text{U}^{233}$ ,  ${}_{92}\text{U}^{235}$ ,  ${}_{92}\text{U}^{238}$ , and  ${}_{94}\text{Pu}^{239}$ , are difficult and time-consuming operations. In general, the efficient recovery of plutonium from bomb debris requires five to six hours for a trained chemist utilizing the equipment and techniques of the semi-microchemical laboratory. The skill required for this analysis is at least on the level of the highly-trained B.S. in Chemistry. Moreover, the specialized equipment and reagents required for this determination are not those generally employed for field laboratory techniques.

Unless it exists in fairly large quantities in the field, uranium is difficult to determine because of its low specific activity. In general, the determination of uranium in bomb debris is accomplished by extremely difficult extraction and electroplating techniques.

The identification of alpha emitters by energy of radiation is equally difficult. Because of the low range of alpha particles in matter, it is impractical to determine alpha energy by the use of solid absorbers. This technique had, of course, been employed successfully in the analytical laboratory<sup>1</sup> using mica or aluminum absorbers or increasing air pressures in a geometry-constant parallel-plate ionization chamber. Ionization chambers connected to multi-channel pulse-height analyzers have been used, as well as cloud-chamber photographs of alpha tracks, magnetic deflection, and track length measurements in nuclear photographic emulsions.

Two major obstacles exist, however, to the determination of alpha energy in the field.

a. Alpha/Beta Ratios

The first of these obstacles is the extremely low ratio of alpha to beta radiation in normal bomb debris. Even if relatively large amounts of bomb debris were processed, only extremely small disintegration rates of alpha radiation would be recovered. Some figures on the ratio noted will demonstrate the magnitudes involved:

If we assume that the critical mass of a weapon is [REDACTED]  
 ${}_{94}^{239}\text{Pu}$  and that the weapon efficiency [REDACTED]  
of the available fuel was fissioned, then the bomb debris contains [REDACTED] plutonium and the fission products from [REDACTED]

1) Range of  $\text{Np}^{237}$  alpha particles in Air, LaChapelle, T. J., Paper 14.1, The Transuranium Elements Vol. II, p. 968 MNES, McGraw-Hill (New York) 1949

plutonium. Any plutonium which may be produced in the uranium tamper of the weapon will be considered negligible as will the alpha contribution from the uranium itself. Using the Way-Wigner equation,

$$\text{cpm } (\beta) = 3.12 \times 10^{-4} d^{-1.2} \text{ dpm/f,}$$

where d is in days to obtain the  $\beta$  disintegration rate at several periods of time, the alpha and beta disintegration rates in the debris may be readily calculated.

If we assume that a field laboratory sample comprises  $10^{-1.4}$  of the total bomb debris, the calculated alpha and beta disintegration rates will be roughly those shown in the following table, Table 1.

Table 1

Date after burst	1 day	5 days	10 days	50 days	100 days
Alpha DPM	5	5	5	5	5
Beta DPM	$8 \times 10^6$	$1.1 \times 10^6$	$4.9 \times 10^5$	$7.2 \times 10^4$	$3 \times 10^4$

It is felt that the handling of these large quantities of bomb debris activity to obtain relatively small alpha activities is too hazardous from a contamination point of view for trailer operation. This is particularly true since to count a effectively one requires uncovered samples.

These calculations, of course, are for a normal explosion. In the case of an incomplete explosion or "fizzle", large quantities of alpha activity would be readily available for sampling and examination. The question then arises of how the

analysis of samples taken from high-alpha-activity areas would be performed, and leads us to consideration of the second problem, that of identifying the activity.

b. Identification of Alpha Emitters

It has been proposed to determine the energy of the alpha particles emitted by bomb fuel and tamper isotopes by measuring the ranges of these particles in air. This determination could be accomplished by measuring the counting rate of an alpha sample placed at increasing known distances from the counter. Since alpha particles are emitted from isotopes in monoenergetic groups, there should be an abrupt cut-off point in the radiation flux beyond which no alpha-particles would be detected, corresponding to the range shown by the Bragg curve for that energy. In practice, an alpha source could be mounted on a table beneath a scintillation counter, and the table could be moved away from the source on a calibrated screw. When a thickness of air corresponding to the range of the most energetic alpha particle was interposed between sample and counter, the alpha counting rate would abruptly cease.

Such a technique would depend for its accuracy on three factors:

1. A weightless preparation of the sample, so that none of the energy of the emitted alphas would be lost before the particle left the sample.
2. A constant density of the interposed air, or at least a known density.

3. A known thickness of shield over the phosphor of the scintillation counter, or an arrangement where the photomultiplier tube could see the phosphor scintillations but no other light at any time.

It is felt that the first requirement would be difficult to achieve under field conditions, since a source sufficiently active to count would probably be prepared from a solution containing some dissolved solids. The second and third requirements are, of course, readily achieved.

c. Theoretical

A useful approximation for determining the mean range of an alpha particle in air is the equation

$$\bar{R} = 0.518 E^{3/2}$$

wherein R is the range in air at 760 mm. pressure and 15°C temperature and E is the particle energy in Mev. The equation is applicable for obtaining the mean range for alpha particles between 3 and 7 Mev.

d. Experimental

Alpha sources were prepared by evaporating solutions of  ${}_{94}\text{Pu}^{239}$ ,  ${}_{84}\text{Po}^{210}$ , and  ${}_{93}\text{Np}^{237}$  on glass discs. The disintegration rates of these sources were determined by counting the sources in calibrated scintillation counter arrangements.

A variable-geometry counting set-up was established which comprised a scintillation counter probe connected to a scaler and rigidly mounted in a vertical position. Beneath the phosphor

of this probe was mounted a platform fixed to the top of a threaded shaft held in a fixed collar. A pointer traversing a fixed divided scale was mounted on the bottom of the shaft. With this arrangement the distance between the phosphor of the counter and the platform could be varied by rotating the shaft in the collar; and it could be measured by observing the position of the pointer on the scale. An arrangement similar to this is proposed for use in the field laboratory for determining alpha energy.

With this apparatus, which is shown in Appendix III of the Appendix, the counting rates of the sample at various distances from the phosphor could be measured, and the distance determined at which counting ceased. Since it was postulated that this distance should correspond to the range of the alpha particle in air, this distance was recorded, and compared with the distance calculated for the known alpha energy. The data thus obtained are presented in Table 2. A correction was made for the thickness of the aluminum window covering the phosphor.

Table 2

Isotope	Energy, Mev.	Calculated Range, cm.	Experimentally Determined Range
$_{84}\text{Po}^{210}$	5.30	3.9	3.7
$_{93}\text{Np}^{239}$	4.77	3.2	2.6
$_{94}\text{Pu}^{239}$	5.15	3.7	3.4



It is believed that the discrepancies between the calculated and experimental ranges are due to several factors.

1. The fact that the alpha flux was uncollimated and the geometry of the counting therefore varied as a function of the sample-phosphor spacing.
2. Since the pitch of the screw was quite coarse and the phosphor of the alpha probe covered with  $0.65 \text{ mg/cm}^2$  aluminum foil, the exact measurement of small increments of air density was not possible. For this reason, the mean range of the alpha particle was measured rather than the residual range. It should be noted, however, that calculations made with the equation given above yield the mean range of the alpha particles used.
3. The alpha sources were prepared by evaporating solutions containing different concentrations of solids onto glass discs. These sources were perceptibly thick, although far thinner than most radiochemical precipitates. The precipitates could therefore not be considered to be weightless.

However, it is felt that in general determinations of this type will suffer from defects noted above, and particularly from the third factor. For this reason, the identification of alpha emitters by range measurement will not be employed in the manual. Moreover, no simple methods of physical isotope identification have been uncovered for inclusion in the manual.

e. Conclusion

Since the physical method of identifying alpha emitters shows so little promise, a simplified chemical method for identifying plutonium will be included in the manual. While this procedure will undoubtedly be characterized by a low recovery, it will serve to distinguish the extremely hazardous plutonium from the uranium and polonium likely to be present in bomb debris.

2. Silicon Determination

It was requested that methods for determining radioactive silicon be included in the manual to aid in the evaluation of neutron-induced soil activity. The analytical literature was therefore studied for methods of gravimetrically determining silicon.

It should be pointed out that any silicon procedure should be simple and fast. The silicon radioisotopes are quite shortlived, as can be seen from the following table.

Table 3

Isotope	Half-Life	Radiation Energy, Mev.	Source
$^{27}_{14}\text{Si}$	4.9s	3.5 $\beta$ +	Si( $\gamma$ ,n)
$^{31}_{14}\text{Si}$	2.62h	1.5, 1.8 $\beta$	P(n,p), Si(n $\gamma$ )

It is therefore unlikely that hazardous neutron-induced quantities of active silicon will be present after about 26 hours following an atomic explosion.

The analytical literature was searched for usable precipitates of silicon compounds. However, the bulk of the silicon analytical

schemes involving the element rely on the volatility of  $\text{SiF}_4$  and determine silicon by difference, a method clearly unsuitable for radiochemical analysis.

In the initial stages of most analyses, silicon is brought down as  $\text{SiO}_2$ , which is prepared by dehydrating silicic acid,  $\text{H}_2\text{SiO}_3$ . The silicic acid is, however, a fairly flocculent or gelatinous precipitate in acid solution, and its extensive surface sorbs significant quantities of many of the other elements present in the solution. These elements tend to follow the silicon, and for this reason the determination of the element as  $\text{SiO}_2$  seems fairly impractical.

The Radiation Laboratory at the University of California was approached, to determine whether the cyclotron target analytical procedures used there included a usable silicon scheme. Their scheme was substantially the one outlined above, wherein radioactive silicon is determined as  $\text{SiO}_2$  in the presence of several other activities and holdback carriers. This procedure was employed during the Las Vegas tests but found to be unsatisfactory. It was therefore considered impractical for field laboratory use.

It was concluded that no analytical scheme was available at this time for inclusion in the manual.

### 3. Strontium Analysis

An analytical method for the determination of strontium in fission products was tested in the laboratory at Berkeley and in the field laboratory at Las Vegas by Mr. Anderson. The procedure employed is that of the radiochemical procedures in general use,

wherein strontium is separated in the barium scheme in the supernatant solution from the barium chromate. The insoluble strontium oxalate is then brought down, decontaminated and counted.

This procedure was found to work very satisfactorily in the field, and will be included in the manual.

#### 4. Dip Counting Procedures

It was proposed that dip counting procedures for the radioassay of liquids be included in the manual. A glass dip tube, the Tracerlab TGC-5, having a  $30 \text{ mg/cm}^2$  wall thickness was examined for this purpose both in the field laboratory at Las Vegas and in the laboratory at Berkeley. Procedures for the use of this equipment will be included in the manual.

#### 5. "Gamma Sandwich"

The use of a composite beta-particle absorber was recommended for the separation of beta and gamma radiation in the field laboratory counting equipment. The absorber in question would be composed of a disc of Al having a thickness of  $1.7 \text{ g/cm}^2$ , a disc of Pb having a thickness of  $1.9 \text{ g/cm}^2$  on the Al disc, and another disc of Al having a thickness of  $130 \text{ mg/cm}^2$  on the lead disc. This absorber, when placed over a mixed beta-gamma source, filters out the beta and permits a minimum of secondary radiation from the filtration to reach the counting element.

An absorber of this type was made and tested at the Jangle tests. Procedures for its use will be included in the manual.

## 6. The Cascade Impactor

Methods for determining in the field laboratory the particle size of air-borne activity were investigated. The cascade impactor, of the type designed and marketed<sup>(2,3)</sup> in England, was felt to present the best possibilities.

In the cascade impactor, the air containing the aerosol to be examined is pumped through a series of rectangular jets of decreasing width. Opposite each jet is a glass slide upon which the aerosol particles are collected. The air passes through the jets at velocities which increase as the jet widths decrease, and with increasing velocity, particles of smaller diameter are impacted on the slides. An impactor was purchased by the Tracerlab Manual Contract group, and tested in Berkeley for use. A diagram of this particular model appears as Appendix IV of this report together with a photograph thereof.

It was proposed that instead of collecting the aerosol particles directly on a glass slide, they be collected on circular glass discs mounted on the slides. These discs could, after sampling, be removed from the impactor, mounted on brass planchets and counted as are other samples. Since a given size of range of aerosol is collected on each stage of the impactor, the size ranges of sampled aerosol in which the activities were distributed could readily be determined.

---

1) Porton Document 1600 (U.5968) May, K.R. 1 April 1944.

2) The Cascade Impactor: An Instrument for Sampling Coarse Aerosols  
May, K. R. J. Sci. Inst. Vol. 22, No. 10, Oct. 1945 (Great Britain).

A simulant aerosol, carbonyl iron dust, was used in the Berkeley laboratory to test the cascade impactor, and photomicrographs of the aerosol fraction collected on each of the four stages are presented as Appendix V. It will be seen that each stage collects a certain size fraction of the dust.

It was proposed to test the impactor under field conditions at the Jangle Operations at the Las Vegas Test Site. It proved impossible to do so, however since no facilities were provided for setting it up in the area around the burst, where air-borne activity would be encountered. For this reason, insufficient data on the proposed procedure was amassed. It is felt that no procedures for employing the cascade impactor in the field laboratory should be included in the manual until more field testing has been performed, perhaps at future tests.

It should nevertheless be emphasized that the cascade impactor appears to be an extremely simple and effective instrument for determining the desired information with the desired accuracy, and its application should be more thoroughly investigated.

## II. THE FALL FIELD PROGRAM AT THE LAS VEGAS TEST SITE

### A. The Mobile Radiological Field Laboratory Participation in Operations Buster and Jangle

The Mobile Radiological Field Laboratory Contract, DA 36-039-sc-5498, provided for the participation of the modified trailer laboratory AN/MDQ-1 (XE-3) in the Fall weapons tests, Operations Buster and Jangle at the Las Vegas Test Site. The group accompanying the field laboratory included both Tracerlab and Signal Corps personnel, and was headed by Mr. Charles L. Blair

of Evans Signal Laboratory. The two members of the Tracerlab Western Division staff to remain at the Site during the tests were Mr. Edwin Anderson, the radiochemist of the Manual Contract group, and Mr. Victor Sloman, an electronics engineer of the Electronics Department.

Although the main function of this group was the evaluation of the modified field laboratory, it was felt desirable to have them evaluate the drafts of the manual already prepared as well. As a consequence, a copy of the drafts of the operations chapters of the manual were sent to Mr. Anderson. The instructions and techniques in the manual were employed in the field laboratory wherever possible, and the comments of the personnel using the techniques collected.

#### B. Visits to the Las Vegas Test Site

In order to assist in the setting up of the field laboratory and to discuss the techniques to be used during Operations Buster and Jangle, Mr. Zentner paid two visits to the Test Site. The first trip from Berkeley to the site was made on October 25, and at this time the mission of the field laboratory was discussed in several conferences with members of the Signal Corps party.

On the second trip, on November 15, a survey was made of the effectiveness of the manual techniques being used by the trailer party. Mr. R. L. Newacheck, the engineer who assisted in the design of the modified field laboratory, accompanied Mr. Zentner on this visit, in order to answer any questions which might arise on the operation of the trailer itself. At this time a conference was held with Messrs. Blair and Shapiro of Evans Signal Laboratory and Messrs. Zentner, Anderson, and Newacheck of Tracerlab,

Inc. to review the manual procedures. Mr. Shapiro also examined the chapter drafts and made comments thereon.

C. The Information Obtained from the Las Vegas Program

With the return of Mr. Anderson from the Test Site, the reexamination and editing of the manual in the light of the new information obtained at the tests began. Considerable revision of a limited number of sample dissolution procedures and some changes in equipment and equipment use were written into the manual.

For example, it was found that the nickel crucibles provided in the field laboratory were insufficiently resistant to such drastic chemical treatments as they experienced in the acid digestion procedures. For this reason, it was found necessary to supply the field laboratory party with platinum dishes in which to perform the digestions; and the use of platinum ware for digestions will be recommended in the manual.

Moreover, since the Jangle tests were surface and underground nuclear fission explosions, phenomena which had never before been studied, it was possible to modify many statements in the manual based solely on theoretical considerations in the light of the experimental measurements.



## DISCUSSION AND CONCLUSIONS

In the course of preparing the manual chapters, and particularly during the participation of the Signal Corps party in the Jangle Operation, a great many questions arose on the procedures already included in the manual drafts. The answers to these questions were supplied by searching the literature on the subjects, discussing the problems with experts at Tracerlab or other research organizations, and by testing in the laboratory, or in the field.

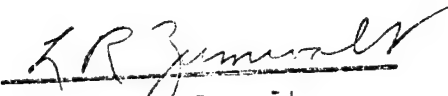
The acquisition of information is, however, a continuous assignment. A great many questions have arisen on the procedures now included in the manual which could not have been asked until those procedures were developed and written. It is recognized that a number of questions will arise from the use of the manual in the field, and it is therefore recommended that continuous research be conducted on the use of the laboratory and the manual. It should be pointed out, for example, that no actual field data on the nature, collection or analysis of radiological warfare agents has been included in the manual, and therefore field tests with such material would be extremely useful.

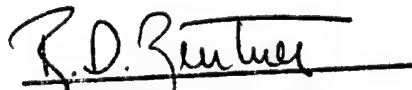
PROGRAM FOR NEXT PERIOD

Since the contract upon which the manual is being prepared ends 15 March 1952, the next quarter will be devoted to reviewing the first completed manuscript of the manual both with the Signal Corps and with Tracerlab personnel.

Any necessary alterations to the manuscript will be made, and the manuscript will be duplicated and resubmitted.

APPROVED:

  
L. B. Zumwalt  
Associate Technical Director

  
R. D. Zentner  
Project Leader

APPENDIX I

U.S. NAVAL RADIOLOGICAL DEFENSE LABORATORY  
SAN FRANCISCO 24, CALIFORNIA

In Reply  
Refer to:  
3-953

SECRET

1 October 1951

Tracerlab, Inc.  
2295 San Pablo Ave.  
Berkeley 2, California

Attn: R.D. Zentner, Contract Project Leader

Gentlemen:

I have received your letter of 19 September and in accordance with your verbal request, would like to confirm our telephone conversation of Friday afternoon, 28 September.

The Radiological Safety Branch is actively pursuing work on the problem of detecting the presence of radioactive material in the human body. Some experimental data has been obtained on laboratory personnel who participated in Operation GREENHOUSE. Further checks are planned on laboratory personnel participating in the forthcoming BUSTER and JANGLE operations. The problem is also being pursued as a part of the normal Radiological Safety Branch's program. In addition, NRDL has several other Scientific Branches whose research programs cover the general problem of possible internal hazards to military personnel from bomb debris. The experimental results will be published periodically in formal reports.

Since active work is being done on these projects it is difficult to present any formal references at this time. However, I am certain that the laboratory will issue periodic reports giving the status of these investigations and there should be a mechanism whereby your group can obtain copies of these reports.

I hope the above information will be useful. I am sorry that I can be of no further assistance to at the present time.

Very truly yours,

(signed: A. L. Baietti)

A.L. Baietti, Head,  
Radiological Safety Branch

SECRET

## APPENDIX II

### IDENTIFICATION OF TRACERLAB PERSONNEL

<u>Project Leader:</u>	Rene D. Zentner Full-time project leader		
<u>Background:</u>	B.S. Stanford University	January	1944
	Research Ass't. Stanford University		1944-45
	Chemical Engineer, Plastics Department E. I. duPont de Nemours and Company		1945-47
	Chemical Engineer, The Firm of Chas. S. Evans San Francisco, California		1947-48
	Research Physical Chemist Tracerlab, Inc.		1948-
<u>Asst. Project Leader:</u>	Edwin E. Anderson Full-time Radiochemist		
<u>Background:</u>	B.S., San Diego State College		1950
	Research Radiochemist Tracerlab, Inc.		1950-

### PART-TIME CONSULTANTS

<u>Biological Effects of Radiation:</u>	Dr. Cornelius A. Tobias		
<u>Background:</u>	B.A., Tech. University, Budapest, Hungary		1939
	Hungarian-American Fellow, University of California, Berkeley, California		1939
	M.A. University of California, Berkeley, California		1940
	Ph.D. (Nuclear Physics) University of California, Berkeley, California		1942
	Physicist, Donner Laboratory of Medical Physics, University of California, Berkeley, California		1942-45

Dr. C. A. Tobias

Biophysics and Fellow, Medical Physics  
Division, University of California,  
Berkeley, California 1945-47

Assistant Professor, University of  
California, Berkeley, California 1947-

CHEMISTRY:

Research  
Radiochemist: M. Abel DeHaan, Jr.

Background: B.A. (Chemistry) University of California,  
Berkeley, California 1942

Research Radiochemist,  
Radiation Laboratory  
University of California,  
Berkeley, California 1942-43

Chemical Engineer and Supervisor  
Chemical Process Group  
Tennessee Eastman Corp.  
Oak Ridge, Tennessee 1943-47

Radiochemist,  
Clinton Laboratories  
Oak Ridge, Tennessee 1947-48

Senior Radiochemist, Chemistry Department  
Western Division  
Tracerlab, Inc. 1948-

Research  
Radiochemist: Loren J. Beaufait

Background: B.S. (Chemistry) University of California,  
Berkeley, California 1942

Assoc. Research Radiochemist,  
Chemistry Department  
University of California  
Berkeley, California 1942-44

Research Radiochemistry Supervisor  
Tennessee Eastman Corp.  
Oak Ridge, Tennessee 1944-46

Loren J. Beaufait

Research Radiochemist  
Radiation Laboratory  
University of California  
Berkeley, California 1946-48

Research Radiochemist  
Western Division  
Tracerlab, Inc. 1948-

Research  
Radiochemist: Leon Leventhal

Background: B.S. (Chemistry) University of California  
at Los Angeles 1942

B. S. (Chemical Engineering) Virginia  
Poly. Inst. 1944

Chemical Engineer  
Fercleve Corp.  
Oak Ridge, Tennessee 1945

Chemist and Chemical Engineer  
Atomic Bomb Laboratory  
Los Alamos Scientific Laboratory  
University of California  
Los Alamos, New Mexico 1945-46

M.S. (Chemistry) University of California  
Los Angeles, California 1948

Radiochemist, Naval Radiological Defense  
Laboratory  
Hunters Point Naval Shipyard  
San Francisco, California 1947-49

Research Radiochemist  
Western Division  
Tracerlab, Inc. 1949-

Research  
Radiochemist: H. E. Menker

Background: B.S. Stanford University 1946

M.S., University of California  
at Los Angeles 1949

Research Radiochemist  
Western Division  
Tracerlab, Inc. 1949-

ELECTRONICS:

Sr. Electronics  
Engineer:

W. H. Faulkner, Jr.

Background:

B.S. Electrical Engineering  
University of Florida

1941

Radio Engineer,  
Radar Installation Branch  
Office of Chief Signal Officer  
Washington, D. C.

1941-43

Radio Engineer  
Rubber Development Corp.

1943-44

Group Leader  
Research and Development Group  
Underwater Sound Laboratory  
Harvard University

1944-46

Radio Engineer  
Cruft Laboratory  
Harvard University

1946-47

Senior Electronics Engineer  
Tracerlab, Inc.  
Boston, Mass., and  
Berkeley, California

1948-

Electronics  
Engineer:

James H. Knapton

Background:

Radio amateur, W6TLB

1941-

U. S. Navy Electronics Technician's Mate

1946-47

B.S. In Electrical Engineering  
University of California

1948

University of California Electronic  
Computer Project

1948-50

Tracerlab, Inc., Electronics Engineer

1950-

FIXED TRACERLAB  
P-12 ALPHA PROBE

RCA 5819 PHOTO-  
MULTIPLIER TUBE

GASKET

ZnS PHOSPHOR

0.65 MG /CM<sup>2</sup> ALUMINUM  
FILM

ALPHA EMITTER

PLANCHET

PLATFORM

COLLAR

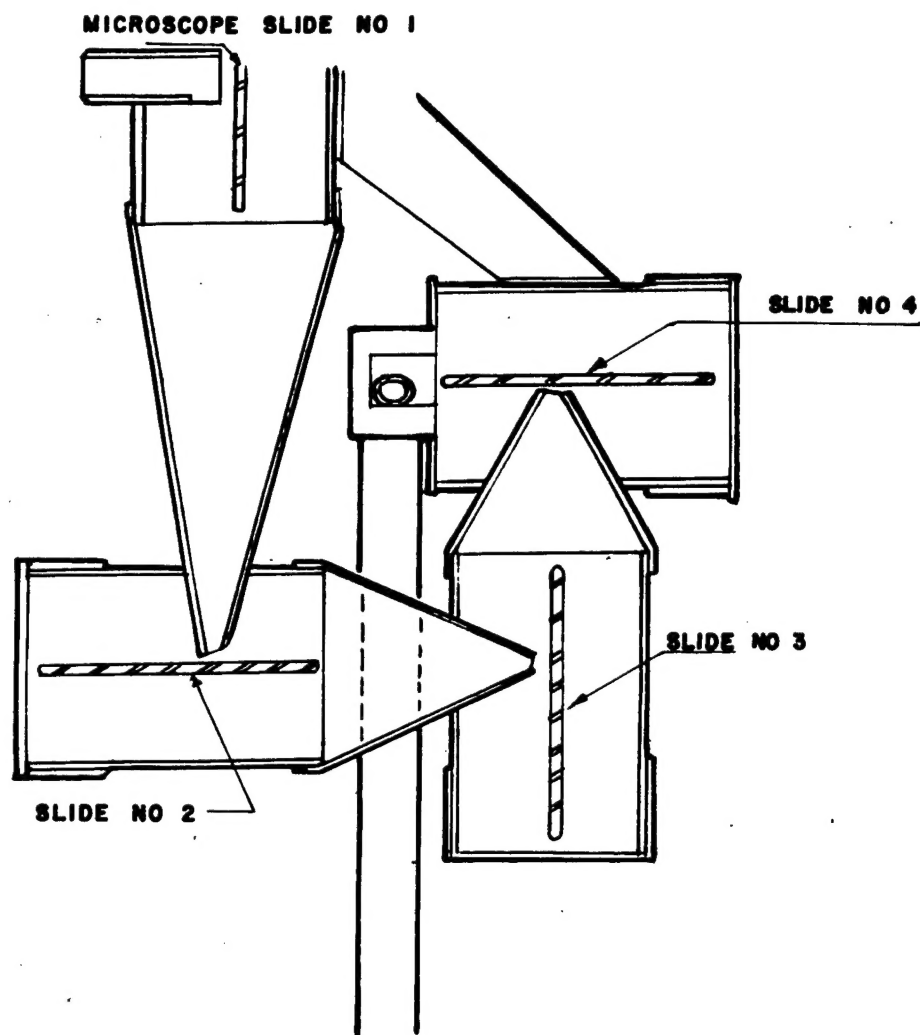
SCALER

POINTER

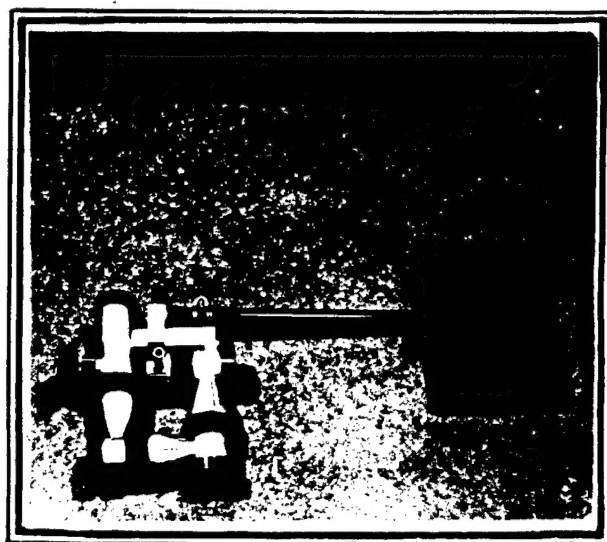
### APPENDIX III

## THE ALPHA-RANGE DETERMINATION APPARATUS

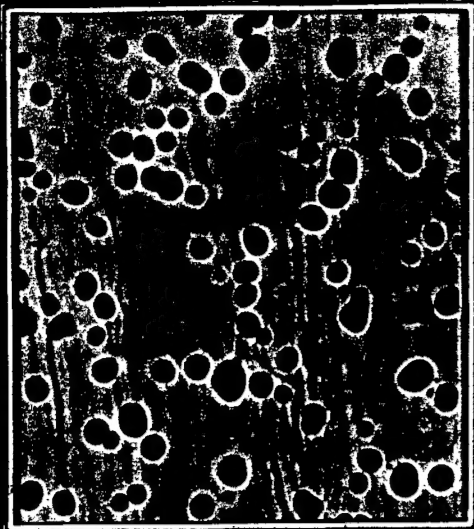




SECTIONAL ELEVATION OF THE  
CASCADE IMPACTOR



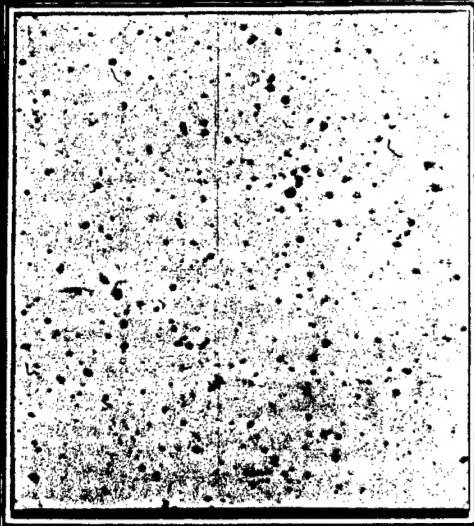
PHOTOGRAPH OF THE  
CASCADE IMPACTOR



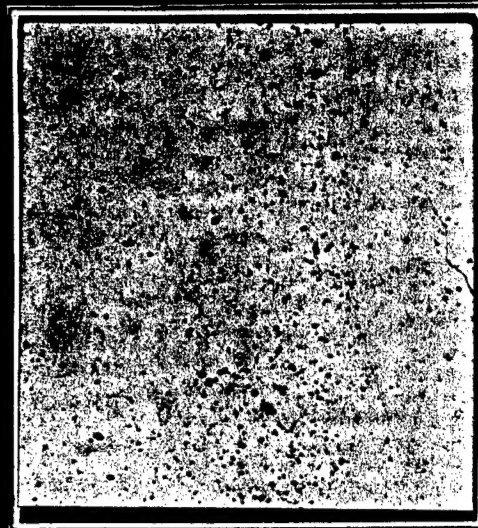
FIRST SLIDE  
200 X



SECOND SLIDE  
200 X



THIRD SLIDE  
200 X



FOURTH SLIDE  
200 X

APPENDIX V

PHOTOMICROGRAPHS OF SAMPLES OF AN  
AEROSOL OF IRON PARTICLES COLLECTED ON THE  
STAGES OF THE CASCADE IMPACTOR

UNCLASSIFIED

SIGNAL CORIS ENGINEERING LAB  
EVANS SIGNAL LABORATORY  
BELMAR, NEW JERSEY

Title of Report: The Manual for the Radiological Field Laboratory

Report No. Third Quarterly Report covering period 15 September to 15 December 1951

Contract No. DA 36-039 sc-5495

Number of Copies: 25

Contractor: Tracerlab Inc.

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